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U.S. AIR FORCE LASER ILLUMINATORS

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U.S. AIR FORCE LASER ILLUMINATORS

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ABSTRACT

The US Air Force is pursuing the development of tactical laser illuminators to be employed by USAF Security Forces in the protection of high-valued assets. Through the effects of illumination, glare, and psychological impact, lasers can provide unequivocal warning, threat assessment based on reaction to the warning, hesitation, distraction, and reductions in combat and functional effectiveness. Two developmental programs are described, including hardware descriptions and Air Force plans for future activities.

LASERS AS TACTICAL ILLUMINATORS

In the present domestic and world political climates, military and law enforcement forces are faced with a growing number of situations in which non-lethal response options are essential. Recent examples include Somalia, Cuban refugee camps, Haiti, Saudi Arabia, and Panama, as well as the riots in Los Angeles and thousands of daily encounters that endanger police officers and bystanders. In these situations, the individual soldier or police officer would benefit from non-lethal options to warn, deter, delay, or incapacitate an adversary. Tactical laser illuminators help to "fill in" gaps in the force continuum between the extremes of verbal challenge and lethal force.

1. What tactical advantages can laser illuminators provide?

Low power (100 – 500 mw) laser illuminators used in a defensive role can induce the effects of illumination, glare, flashblinding, hesitancy via psychological impact, and reductions in combat and functional effectiveness of potential adversaries. These effects are all purposefully intended and proven to be entirely reversible, i.e., no permanent injury is likely to result based upon approved rules-of-engagement. Furthermore, if continuous-wave lasers are employed rather than "pulsed" alternatives, these effects are achieved at exposure levels far below the maximum power allowed by internationally accepted safety standards. Such laser illuminator devices can provide the system operator a unique array of non-lethal response options that can be increased in severity as the situation warrants. These options are:

- **Unequivocal, Language-Independent Warning** – A 1 to 2 foot diameter spot of bright red light illuminating the adversary's torso makes it clear he has been detected, singled-out, and likely has lethal weapons trained on him.
- **Threat Assessment Based on Reaction to Warning** – The intent/motivation of the adversary and the need for a more severe response can be assessed based upon whether the threat surrenders retreats, continues to advance, or raises a weapon in response to the warning. Quick conversion to a lethal response is assumed.
- **Slowing or Stopping the Advance of Individuals Through Temporary Visual Jamming** – Laser "dazzle", glare and flashblinding make it difficult to see a path, road, or obstacles, especially at night.
- **Impairing an Adversary's Ability to See in the General Direction of the Laser Illuminator** – Adversaries looking towards the laser source can see little or no detail about the location and placement of opposing forces.
- **Interfering With an Adversary's Ability to Accurately Aim a Weapon to Return Counter-fire** – Weapon firing accuracy is severely degraded by laser glare.

These tactical laser illuminators can be helpful in delaying and/or disorienting adversaries where innocent bystanders are present, such as hostage rescue, protection of political leaders or military commanders, and flight-line security. Finally, civilian law enforcement applications, such as drug raids and hostage rescues, where a second or two of distraction, fear, or visual impairment can provide the tactical edge needed for a successful engagement.

2. Saber 203

US Air Force Security Forces have documented operational requirements for a rifle-mounted, glare-producing, anti-personnel laser illuminator intended to provide security forces with additional engagement options when encountering adversaries. The integral M-16/M-203 weapon is selected to allow a laser illuminator round (IU) in the form factor of a 40 mm grenade to be loaded into the M-203 grenade launcher tube in place of a high-explosive munition. A separate Triggering Transmitter Unit (TTU) easily fastens to the launcher tube and houses the activation button and "AA" batteries used to power Saber 203. The system operator can illuminate, induce glare, and delay/disorient intruders using the Saber 203 non-lethal laser capability. If the situation escalates and warrants lethal firepower, the operator can fire lethal rounds immediately using the M-16 rifle. Red laser light was selected to provide an unequivocal, language-independent warning irrespective of cultures encountered when deploying worldwide.

Under development at the Electronic Systems Center, Force Protection C2 SPO, Hanscom AFB, MA, Saber 203 is currently completing a two-year Engineering and Manufacturing Development (EMD). The primary objectives of the EMD program are 1) improve the earlier design while managing eye safety to avoid laser eye injuries; 2)

ruggedize system hardware consistent with world-wide deployments; and 3) reduce manufacturing costs consistent with moderate production rates. To meet these goals, design improvements have been accomplished in the areas of beam quality, operating temperature range, electronic drive circuits, and environmental sealing.

Specific design challenges have been to accommodate three subsystem modules within the compact volume of a grenade shell, i.e. within 40 millimeters in diameter by 132 millimeters in length. Modules included are:

- an electronics module with four printed circuit boards;
- a laser module, containing a solid-state diode laser with coiled fiber-optic (used to "homogenize" the beam in order to eliminate localized "hot spots" of output beam intensity);
- an optics module to "spread" the beam in order to achieve the desired "footprint" of laser energy at tactical ranges.

Qualification Test and Evaluation (QT&E) was conducted to validate prototype hardware against the system specification. In August 1998, AFOTEC, the Air Force Operational Test and Evaluation Center will conduct Initial Operational Test and Evaluation (IOT&E) at Kirtland AFB, NM to assess Saber 203's operational effectiveness in real tactical environments. Upon successful testing, AF Security Forces are planning on "trial" deployments for the remainder of the calendar year.

3. HALT

HALT (Hindering Adversaries with Less-than-lethal Technology) is a Saber 203 product improvement under the Air Force "spiral development" philosophy. HALT will accomplish improvements in three areas:

- 1) Totally eye-safe at the aperture. (Saber 203, by contrast, is eye-safe at ranges in excess of six meters);
- 2) Design for compatibility with the universal rifle mount and the future Modular Weapon System, allowing operation on most rifles in the U.S. inventory;
- 3) Capable of autonomous, hand-held operation - - no rifle required. Law enforcement can use as augmentation to sidearm.

HALT, like Saber 203, will allow the illumination of threats with intense (yet eye-safe) red laser light. Activation results in continuous-wave illumination that reverts to a "flicker mode" after ten seconds in order to maximize annoyance and disorientation of the adversary. In addition, HALT will effectively glare at considerably longer ranges than Saber 203 in both day and night conditions and will provide area illumination at a standoff distance of approximately one-kilometer.

Under development at the Air Force Electronic Systems Center, Force Protection C2 SPO, Hanscom AFB, MA, HALT is currently in a Technology Demonstration phase which is planned to be followed by an Engineering and Manufacturing Development (EMD) program in Fiscal Year 1999. The HALT EMD program will culminate in

sixteen months with operational testing to assess tactical effectiveness. Production start-up is envisioned in Fiscal Year 2001.

4. Laser Eye Safety Bio-Effects Studies

Non-lethal weapons for employment in anti-personnel roles require thorough medical and legal study before proceeding to production and deployment. Saber 203 and HALT are not exceptions. Medically speaking, the first question asked by potential military and law enforcement personnel concerns eye safety. Both Saber 203 and HALT are designed to be "eye safe" in the sense that the laser output beam intensity at operational ranges is below the Maximum Permissible Exposure (MPE) - - the safety limit set by U.S. and international standards. These laser illuminators are:

- "Safe" for up to a 10-second exposure
- As "safe" as looking at the sun for longer exposures
- About 10% of the exposure levels produced by some laser pointer and laser firearm sights.

Unfortunately, this is not the whole story. Laser eye damage is not a binary process (no injury below the MPE, definite injury above the MPE), but rather a probabilistic process. The MPE is derived by finding the exposure level (based on intensity, emission wavelength, beam divergence, pulse characteristics, etc.) where 50% of exposures result in minimal permanent injury, then dividing by ten to get the MPE. There is still some probability that an exposure below the MPE will cause an eye injury in any given event - - no one knows, but it is small! The work necessary to fully define the probability of eye damage for all possible values of the aforementioned variables is far too extensive and expensive. Furthermore, the MPE is defined for unintentional exposures, not for intentional exposures like those produced by non-lethal weapons. How is this dilemma to be resolved?

In 1996, the Department of Defense published DoD Directive 3000.3, Policy for Non-Lethal Weapons. The policy states "Non-lethal weapons shall not be required to have a zero probability of producing fatal or permanent injuries. However, while complete avoidance of these effects is not guaranteed or expected, when properly employed, non-lethal weapons should significantly reduce them as compared to physically destroying the same target."

With respect to the Saber 203 program, specifically, funding has been provided to Air Force Research Laboratory - Brooks Air Force Base, to conduct analyses and measurements to accurately determine damage thresholds indicative of permanent injury. The exhaustive efforts at Brooks AFB resulted recently in the Air Force Surgeon General's Office approving Saber 203 for human use testing. Similar investigations are planned for the HALT program.

5. Formal Legal Reviews

Any new weapon, lethal or non-lethal, irrespective of the level of complexity or simplicity, is required by policy to undergo a thorough legal review prior to fielding. Saber 203 and HALT are no exceptions. Each program will be extensively studied by the OSD General Counsel to assure that each non-lethal laser illuminator complies with both the International Laws of Warfare and Compliance with Treaties. This review will occur in earnest once operational testing is completed on each system.

6. Summary

Tactical Laser Illuminators, including Saber 203 and HALT, are intended to provide field commanders and security forces personnel with additional options when engaged in peacekeeping and/or humanitarian missions. With other non-lethal alternative solutions, Saber 203 and HALT help to fill in "gaps" in the force continuum between a verbal challenge on the one extreme and application of lethal force on the other.

Air Force laser illuminators are intended to impart strong messages to adversaries at safe standoff ranges: 1) "You are detected"; and 2) "Lethal Weapons are likely aimed at you". Failure of an adversary to get the message can result in him being directly exposed to eye-safe glare or flashblinding to delay and disorient intruders. In the case of aggressors who choose to continue approaching controlled areas, a lethal response is an additional option.

Both Saber 203 and HALT programs have been conducted with the utmost diligence to assure resulting products are non-injurious to personnel, proven to minimize legal liabilities, and to comply with DoD Directive 3000.3 and other applicable guidance. Production is anticipated in the Fiscal Year 2001 time frame.



USAF SECURITY FORCES LASER ILLUMINATOR SYSTEMS

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POLICY FOR NON-LETHAL WEAPONS

DoD Directive 3000.3

July 1996

- Gives Commanders Flexibility In Employing Non-lethal Technologies And Allows Escalation To Deadly Force If Troops Are Threatened.
- States That Non-lethal Technologies Shall Not Be Required To Have A Zero Probability Of Producing Fatalities Or Permanent Injuries.
- Increases Options Available To A Commander To Minimize Fatalities, Permanent Injury And Undesired Damage To Property.
- Minimizes Need For Post Conflict Reconstruction, Allows Operations To Be Undertaken Where Lethal Force Is Not Viable And Limits The Escalation Of Violence In Peacekeeping Operations.
- Has As A Guideline That Non-lethal Effects Are Intended To Be Reversible.
- Shows Us Forces Are On A Humanitarian Mission And Do Not Want To Hurt Anyone.



Lethal Force

12-ga. Beanbag
12-ga. Wooden Baton
12-ga. Single Pellet
12-ga. Pellets
Sungballs
Baton
Sticky Foam
Physical Force
SABER 203
Expressed Threat
Physical Presence

40mm Beanbag
40mm Wooden Baton
40mm Foam
40mm Sponge Grenade
RCS (CS gas)
Flashbangs
Oleoristin Capsicum (OC)
Barrier Foam
HALT
Implied Threat

No Force

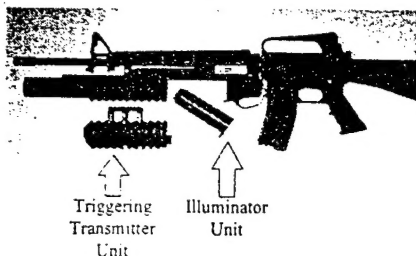


SYSTEM DESCRIPTION

- Active CW Laser In Grenade Shell Form Factor To Operate On M-16/M-203 Weapon
- System Produces Glare In Eyes Of Intruder To Delay And Disorient At Close Range
- Illuminates Intruder At Long Ranges
- Intruder Choices: Retreat, Surrender, Or Signal Intent To Advance On Protected Asset
- User Can "Go Lethal" Quickly With M-16/M-203

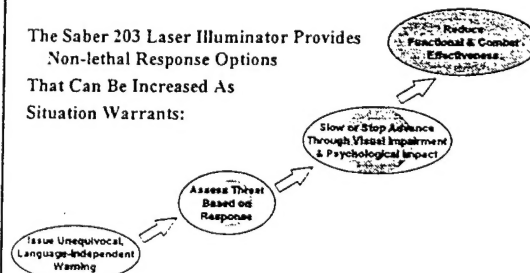


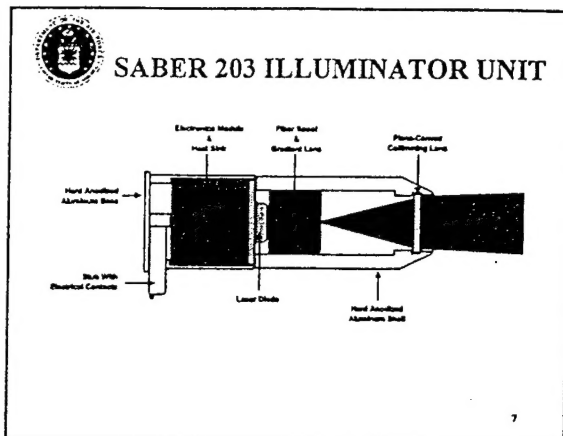
LASER ILLUMINATOR ADDITIONS TO THE M203 WEAPON



SABER 203 CAPABILITIES

The Saber 203 Laser Illuminator Provides Non-lethal Response Options That Can Be Increased As Situation Warrants:





SUPPORT AGENCIES

<ul style="list-style-type: none"> AFSPC/SFO AF/ISFX DOD Non-Lethal Executive Agency ESC/ED ACC OSD JAG AFRL - (Kirtland AFB) AFRL - (Brooks AFB) 46TW AFOTEC 	<p>Program Direction Funding Funding</p> <p>Force Protection C7 SPO Requirements Legal Review Laser Systems Consultant Bioscience, Laser Safety OT&E IOT&E</p>
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SABER 203: TODAY'S STATUS

- Qualification Test & Evaluation Completed Successfully (7/97)
- Manufacture Of Equipment Sets Underway For Force-on-force Field Evaluation
- Briefed AF Surgeon General (AFMOA) - Secured Approval For Human Use Testing - Mar 98
- IOT&E At Kirtland AFB, NM - Aug 1998
- "Trial" Deployments Planned For Late Cy98

EYE SUSCEPTIBILITY

Wavelengths and Wavebands

SABER (650 nm - red)

- Ocular Sensitivity
 - Retina
 - Visible (SABER)
 - Near Infrared
 - Cornea and Lens
 - Ultraviolet
 - Far Infrared

SABER 203 HUMAN VULNERABILITY

- Glare and Flashblindness - Temporary Effects Only
- No Permanent Injury When Used According to the CONOPS - Will Be Below the ANSI Standard
- SECDEF Policy Prohibits Lasers Specifically Designed for Permanent Blinding
- SABER 203 Will Satisfy DoD Directive 3000.3, Policy for Non-lethal Technologies (NLT)

PERSONNEL SUSCEPTIBILITIES

VISUAL JAMMING
Glare and Flashblindness only



SABER 203 EYE SAFETY CONCLUSIONS

- AFRL/HEDO Will Assure Eye Safety Prior to QOT&E
 - Effective Dosage Studies
 - SABER Laser Beam Characterizations
 - A Thorough Human Use Review Process
 - Subject Safety Briefings, System Training, and Eye Exams
- The SABER 203 Laser Illuminator Will Be Eye-safe If Used Within the Guidance of the CONOPS
- There Will Be No Eye Injuries for Laser Exposures That Are Within the ANSI Standards ... Including SABER 203!

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HINDERING ADVERSARIES WITH LESS-THAN-LETHAL TECHNOLOGY (HALT)

A USAF "Spiral" Development Program
Derived from Saber 203

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SABER & HALT COMPARISON

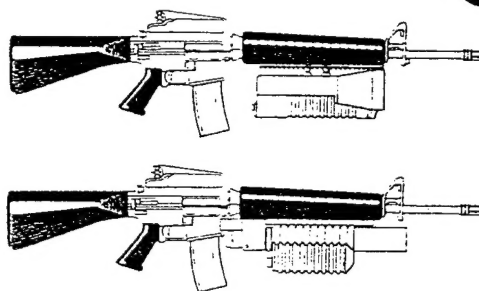
- HALT Will Be Eye Safe At The Aperture; Saber Has A Nominal Ocular Hazard Distance Of 6 Meters
- HALT Will Mount To Any Weapon (M-16 Initially); Saber Limited To M-203
- HALT Will Be Capable Of Autonomous, Hand-held Operation (EMD Configuration)
- HALT Can Provide Area Illumination To Ranges In Excess Of 800m - Allows Engaging Threats At The Max. Range Of The M-16 Rifle

FOR THESE REASONS,
HALT IS VIEWED AS BEING OF SIGNIFICANT PRODUCTION
POTENTIAL FOR THE MULTI-SERVICES

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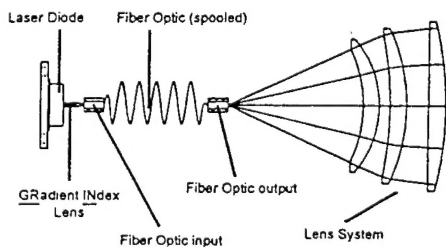
HALT SYSTEM (as of January PMR) COMPARISON TO SABER 203 SYSTEM



16



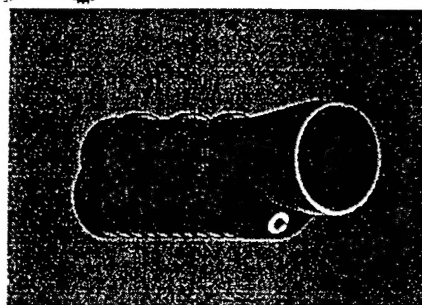
OPTICAL SYSTEM GENERAL LAYOUT



17



HALT Mechanical Design Solid Model of Device



18

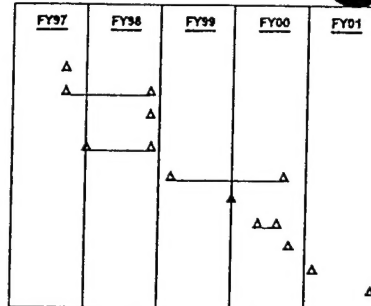


HALT Roadmap to Production



ACTIVITY

- Tech. Demo Program
 - Award
 - Contracted Effort
- Demo Units for DOJ, FPBL
- Develop Joint-Service Requirements
- EMD-Program (Follow On)
- QT&E
- QOT&E
- MSIII Acquisition Decision
- Award Production Contract
- IOC



SUMMARY

- Saber 203 And HALT Provide A Non-lethal Force Capability Complying With Department Of Defense Non-lethal Policy And Laser Eye Safety Standards
- Host Weapon Allows Rapid Conversion To Lethal Force If Necessary
- Users Have Additional Engagement Options For Peacekeeping and Humanitarian Missions.
- Tactical Laser Illuminators Offer Promising "Dual Use" Potential For Civilian Law Enforcement